Lowell Observatory

STATUS REPORT NO. 8 - NsG-451

January 1, 1967 thru June 30, 1967

PURPOSE OF GRANT

Studies in planetology, including the collection and interpretation of planetary information.

PERSONNEL

W. A. Baum, Director
S. E. Jones, Photographer-Observer
K. G. de Groff, Photographer-Observer
H. S. Horstman, Research Assistant and Secretary
K. Rost, Electronics Engineer
J. T. Johnston, Electronics Technician, from February 27
B. M. Brush, Mechanical Engineer, thru May 31
G. Okonieski, Mechanical Engineer, from May 29
R. L. Millis, Laboratory Assistant, thru February 17
S. D. Pratt, Photographic Assistant
N. O. Cook, Photographic Assistant
B. L. Brooks, Maintenance, half-time
H. L. Giclas, Administration, one-quarter time
H. J. Scheele, Administration, one-quarter time

ORGANIZATION AND DISTRIBUTION OF PHOTOGRAPHIC MATERIAL

Automatic processing equipment was installed in our photographic laboratory on April 5. This equipment was obtained partly in order to speed up the copying of planetary plate collections and partly to provide close sensitometric control for the duplication of calibrated plates. The new processing machine is Trans-Flo Model 1207 made by General Aniline and Film Corporation. It is equipped with automatic replenisher and water-temperature control. Exposed films fed through this machine are developed, fixed, hypo-eliminated, washed, and dried under very well controlled conditions.

Following initial installation of the new processing machine, the first six weeks were devoted to the testing and establishing of operating procedures. It is now possible to process approximately 150 copies per hour on 4x5-inch film. Whereas hand processing formerly took three-quarters of the total time spent by darkroom personnel, machine processing now takes less than one-fourth. More than one person or group can therefore have access to the machine.

During the first few months of the year, before the new processing machine was installed, the photographic laboratory completed the copying of all early Lowell Mars plates taken before photometric calibration strips began to be used in 1926. This brought the total number of direct contact copies of the Lowell collection to 3,480, prepared from 870 original plates.

Most plates of suitable quality from the same period have also been composited. All together, first-step composites have been made from 595 plates dating from the beginning of Martian photography at Lowell in 1903 through August 29, 1926. From 162 of these, negatives and four positive copies have been prepared, and some of these copies have already been forwarded to Meudon.

Following the installation and testing of the new processing machine, 452 contact copies have been made from 113 original Lowell Mars plates obtained during the oppositions of 1965 and 1963. The present plan is to continue backward in time from the opposition of 1960-61 through the opposition of 1926, thereby completing the contact copying of the Mars plates in the Lowell collection. Attention will then be turned to the contact copying of plates of other planets and then to selected compositing. At some appropriate time, attention will also be turned to the copying of new observations obtained from 1967 onward. All of this new material is on 35-mm film instead of on glass plates.

The work of extending, checking, and correcting our punched-card records of the plate collection has been continued. A duplicate set of punched cards pertaining to the Lowell plate collection has been prepared and furnished to New Mexico State University Observatory.

INSTRUMENTATION

A new planetary camera was put into operation during the present report period. This camera utilizes 35-mm motion-picture film, and it provides for a pre-set choice of exposure time and of intervals between exposures. The complete camera system consists of several modules. The film-transport mechanism is a commercial unit manufactured by Neyhart Enterprises, Inc. The total film-gate area is divided into two parts, namely, an 18x18-mm area for the incoming planet image, and a 6x18-mm strip at one side for recording time, date, and exposure information. These quantities are optically projected from a data box on the side of the camera head. The electrical signals that control the shutter and film-advance mechanism of the camera head are supplied by a solid-state electronic circuit located in a separate cabinet. In front of the camera head are three modular units to provide for focusing, guiding, color filtering, and magnification selection. These features enable a camera of this kind to be conveniently adapted to different telescopes.

Another instrument completed during the present report period was a two-channel photoelectric polarimeter. This instrument provides for the simultaneous reading of two orthogonal planes of polarization provided by a three-element Wollaston prism. At the focal plane of the telescope, the entrance diaphragm of the polarimeter can be made to scan across an image repeatedly at a linear rate. The scanning aperture plate is driven by a cam. Its outside surface is tilted and polished so that the observer can watch the reflected image and monitor the motion of the aperture. The position angle of the scanning motion can be chosen independently of the polarization angles being observed. With the aid of a depolarizer, the same instrument can also be used as a conventional area scanner. The photoelectric outputs of the two channels of the polarimeter are fed into pulse amplifiers and a multichannel analyzer. The data are recorded on punched tape and are later reduced with an IBM 1130 computer.

Work is progressing on a new area scanner that will also use pulse amplification and a multichannel analyzer readout. The design of this instrument represents an advance both in mechanical features and in electronic sophistication over earlier area scanners already in use here at Lowell Observatory.

The special planet plate projector described in Status Report Nos. 6 and 7 was received from the Richardson Camera Company in January. It was put through a series of tests and adjustments during the first few weeks after it arrived. Photographic plates bearing planet images can be projected onto a screen where the size and orientation of individual images can be made to match a coordinate grid in the screen plane. The locations of surface features and clouded areas can then be read off in a rapid manner. Plates are supported on a stage that provides accurate positioning and orientation. The basic design of the instrument and the preparation of the coordinate grids to be used with it were done at the Planetary Research Center.

OBSERVATIONS

Immediately upon completion of the new 35-mm automatic sequencing camera in January, it was put into nearly continuous service for the photographing of planets. During January and February, the camera was used both on the 24-inch Lowell refractor and on the Perkins 72-inch reflector for obtaining images of Jupiter. From March through June, it was used without interruption on the 24-inch refractor for obtaining images of Mars. Some of the work on Jupiter included long sequences of time-lapse photography, but most of the observations were made in the form of 15- to 20-frame bursts. These bursts produced filmstrips about a foot long containing a series of similar images very much like those formerly recorded on photographic plates. All of the images in such a group have normally been taken in a sufficiently short time that planetary rotation does not produce a significant smearing when selected images of the group are photographically combined into a composite enlargement. All together, there were 514 filmstrips of Mars obtained on 85 nights. Except for some of the time-lapse work at an image scale of 21 arc-seconds per millimeter, most of the planet photography with the new camera has been done with a Barlow lens to yield an image scale of about 3.5 arc-seconds per millimeter. Such a scale appears to be a favorable compromise for the grain, resolution, and speed of the currently preferred emulsions.

Jupiter, Mars, and Venus were all observed photoelectrically during the present report period with a combined area-scanner and spectrum-scanner. The spectrum-scanner was locked at fixed selected wavelengths, while the entrance aperture of the combined system was made to scan narrow strips across the planetary images. In most cases, ten wavelengths were used, ranging from 3390Å to 6050Å. The widths of the passbands were always 30Å or less. The widths and lengths of the entrance apertures were in the range between 0.5 and 1.8 arc-seconds. Scans of Jupiter were obtained under relatively favorable conditions on about eight nights, and a similar amount of material was obtained on Mars. About one-fourth of the scans in both cases ran from pole to pole, while the others were made parallel with the equator. The Jupiter results provide quantitative measurements of limb darkening as a function of wavelength, as well as differential spectral energy distribution data for the belts as compared with regions between belts. The Martian observations provide spectral energy distribution data for about ten blue clouds and one yellow cloud. Blue clouds seem to have a strongly peaked reflectivity in the violet, with much less relative brightness both in the ultraviolet and the red regions. The scans of Venus were made under less favorable conditions, but they clearly indicated that the technique could be applied to Venus in the daytime as well as at night. It will be of interest to see whether the faint traces of cloud patterns that sometimes seem indicated on ultraviolet photographs can be photoelectrically confirmed.

The new two-channel differential photoelectric polarimeter has been used experimentally to scan across Mars. Tentative results appear to indicate a very strong dependence of polarization upon wavelength, the effect being stronger at shorter wavelengths. From the dependence of polarization both upon wavelength and upon phase angle, it may eventually be possible to say more about the nature of the particles that make up the Martian "clouds." Reduction of the Martian observations obtained this year are now in progress.

An attempt was made with an area scanner to obtain photoelectric observations of the Martian satellite Phobos at moments when it is being eclipsed by the Martian atmosphere. A similar attempt was made in 1965. One purpose of these observations has been to seek information about the density of the Martian atmosphere. Another purpose has been to improve data for determining precise orbital elements for Phobos, which might perhaps serve as a future orbiting base for landing space vehicles. Owing to unfavorable weather at the particular moments required, the results obtained this year were again marginal, but reductions are in progress.

PLATE STUDIES

Following completion of the special plate projector in January and its adjustment in February, the Mars Cloud Survey has been making steady progress. The degrees of cloud or haze observed on various regions of the planet are expressed in terms of a numerical code, and the coded data are punched onto cards for statistical analysis in our IBM 1130 computer. These cloudiness data have been read from all Mars plates from the oppositions of 1965, 1963, 1960-61, and 1958. The present plan is to continue this plate reading back through the opposition of 1954 before undertaking an initial analysis of topographic, seasonal, and diurnal effects. Mars plates prior to 1952 are being separately examined for particularly discrete recurrent clouds whose displacements between successive dates can be used to estimate Martian wind velocities. Details of this Mars Cloud Survey are contained in a series of progress reports, as well as a general report dated February 1967.